

CLAIMS

1. A developing apparatus comprising:

a substrate holding unit that holds a substrate in a horizontal attitude, the substrate having an exposed resist thereon;

a rotational drive mechanism that rotates the substrate holding unit, holding the substrate, around a vertical axis;

a developer nozzle that ejects a developing solution toward the substrate, the developer nozzle having an ejection port having a shape of an elongated slit; and

a moving mechanism that moves the developer nozzle in a substantially radial direction of the substrate, the moving mechanism including a nozzle support unit to support the developer nozzle;

wherein the nozzle support unit of the moving mechanism is configured to support the developer nozzle such that a longitudinal direction of the ejection port is oriented toward a center portion of the substrate when the ejection port is located above the substrate; and

wherein the developer nozzle is moved from a peripheral portion of the substrate toward the center portion of the substrate while ejecting the developing solution in a form of a strip through the ejection port and while rotating the substrate around the vertical axis, thereby to supply the developing solution to a surface of the substrate in a spiral form.

2. The developing apparatus according to claim 1, wherein the ejection port has a width in a range of 0.1 mm to 1 mm and a length in a range of 8 mm to 15 mm.

3. The developing apparatus according to claim 1 or 2, further comprising:

a temperature regulating unit for controlling temperature of the developing solution to be supplied from the developer nozzle according to a type of the resist on the substrate or a

specific geometrical characteristic of a pattern of the resist.

4. The developing apparatus according to claim 1 or 2, wherein:

said apparatus includes plural number of said developer nozzles, and each of the developer nozzles is provided with a temperature regulating unit to control the temperature of a developing solution,

said developing apparatus further comprising means for selecting a particular one of the plurality of developer nozzles, wherein the temperature of the selected developer nozzle has been adjusted according to a type of the resist to be developed on the substrate or a specific geometrical characteristic of a pattern of the resist.

5. The developing apparatus according to claim 4, wherein while said one developer nozzle is selected, the temperature of a developing solution for another developer nozzle is adjusted.

6. The developing apparatus according to any one of claims 3 to 5, further comprising a control unit for:

storing data showing relationship between types of resists on the substrate to be developed or specific geometrical characteristics of patterns of the resists and developing solution temperatures suitable therefor; and

controlling, based on the data, the temperature regulating unit to adjust the temperature of a developing solution to a value suitable for a resist to be developed.

7. The developing apparatus according to claim 4, wherein:

each of the developer nozzles is provided with, in addition to the temperature regulating unit, a concentration control unit for controlling a concentration of the developing solution;

the temperature and the concentration of the developing solution for a selected developer nozzle are adjusted according

to the type of the resist or the specific geometrical characteristic of the pattern of the resist.

8. The developing apparatus according to claim 7, wherein while one developer nozzle is selected, the temperature and the concentration of a developing solution for another developer nozzle are adjusted.

9. The developing apparatus according to claim 7 or 8, further comprising a control unit for:

storing data showing relationship between: types of resists or specific geometrical characteristics of patterns of the resists; and developing solution temperatures suitable therefor and developing solution concentrations suitable therefor; and

controlling, based on the data, the temperature regulating unit and the concentration control unit to adjust the temperature and the concentration of a developing solution to values suitable for a resist to be developed.

10. The developing apparatus according to any one of claims 1 to 9, further comprising:

a surface treatment liquid nozzle that supplies a surface treatment liquid to the surface to enhance wettability of the surface before the developing solution is supplied to the surface of the substrate.

11. The developing apparatus according to any one of claims 1 to 10, further comprising:

a rinse liquid nozzle that supplies a rinse liquid to the surface of the substrate after the developing solution is delivered to the surface; and

an surfactant supply nozzle that supplies a surfactant to the surface of the substrate after the rinse liquid is supplied to the surface through the rinse liquid nozzle.

12. The developing apparatus according to any one of claims

1 to 11, wherein movement of the developer nozzle from the outer portion of the substrate toward the center portion of the substrate is stopped when an end, on a side of the center portion of the substrate, of the ejection port of the developer nozzle has reached a position corresponding to the rotational axis of the substrate.

13. A developing method comprising the steps of:

holding a substrate in a horizontal attitude on a substrate holding unit, the substrate having an exposed resist thereon;

moving a developer nozzle, ejecting a developing solution in a form of a strip having a width oriented toward a central portion of the substrate, from a periphery of the substrate toward a center portion of the substrate, while rotating the substrate about a vertical axis, thereby spirally supplying the developing solution onto a surface of the substrate while allowing the developing solution to flow radially outwardly; and

stopping supplying the developing solution through the developer nozzle and supplying a rinse liquid to the surface of the substrate through a rinse liquid nozzle.

14. The developing method according to claim 13, wherein an ejection port of the developer nozzle has a width in a range of 0.1 mm to 1 mm and a length in a range of 8 mm to 15 mm.

15. The developing method according to claim 13 or 14, wherein the temperature of the developing solution is controlled according to a type of the resist, to be developed, on the substrate or a specific geometrical characteristic of a pattern of the resist.

16. The developing method according to claim 13 or 14, further comprising the step of:

selecting one of a plurality of developer nozzles, which have been set to eject developing solutions at different temperatures, based on a type of the resist to be developed on

the substrate or a specific geometrical characteristic of a pattern of the resist.

17. The developing method according to claim 16, further comprising the step of:

while one developer nozzle is selected, adjusting the temperature of a developing solution for another developer nozzle.

18. The developing method according to claim 13 or 14, wherein the temperature and concentration of the developing solution are controlled according to a type of the resist, to be developed, on the substrate or a specific geometrical characteristic of a pattern of the resist.

19. The developing method according to claim 18, further comprising the step of:

while one developer nozzle is selected, adjusting the temperature and concentration of a developing solution for another developer nozzle.

20. The developing method according to any one of claims 13 to 19, further comprising the step of:

moving the rinse liquid nozzle to a position near the developer nozzle before the developer nozzle stops ejecting the developing solution.

21. The developing method according to any one of claims 13 to 19, wherein the developing solution supplying step includes moving the developer nozzle from the periphery of the substrate toward the center portion of the substrate a plurality of times while ejecting a developing solution through the developer nozzle.

22. The developing method according to any one of claims 13 to 19, wherein the developing solution supplying step includes

supplying the developing solution to the center portion for a predetermined period of time, after moving the developing solution nozzle from the periphery of the substrate toward the center portion of the substrate.

23. The developing method according to any one of claims 13 to 22, further comprising the step of:

supplying a surface treatment liquid to the surface of the substrate to enhance wettability of the surface of the substrate, before supplying the developing solution.

24. The developing method according to any one of claims 13 to 23, further comprising the steps of:

supplying a rinse liquid to the surface of the substrate after supplying the developing solution; and

supplying a surfactant to the surface of the substrate, after supplying the rinse liquid.

25. The developing method according to any one of claims 13 to 24, wherein movement of the developer nozzle from the outer portion of the substrate toward the center portion of the substrate is stopped when an end, on a side of the center portion of the substrate, of the ejection port of the developer nozzle has reached a position corresponding to the rotational axis of the substrate.